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Corporate innovation in relation to IPO, enterprise value and R&D expenditures: Evidence from Finnish companies gone public

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ABSTRACT

In this paper, I examine the innovation activities of Finnish companies that have conducted an initial public offering during 1988-2012. The study provides novel analysis on innovations in relation to IPO, enterprise value and innovation investment within important Finnish companies. First, using unique innovation data collected by Technical Research Centre of Finland (VTT) and national patent data, I find that going public increases the number of innovations and patents while it affects negatively on the innovation novelty for Finnish market and increases the novelty for international markets. The novelty effect is emphasized within high-tech industry while also patent data supports a transition to international markets. Second, emphasizing the importance of innovations on performance, I find that innovations have a positive effect on enterprise value. Third, regarding the financing of innovations, the findings support a close link between increased R&D expenditures and innovations as well as indicate that more complex innovations tend to receive more public subsidies for development.

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I. Introduction

I.A. Innovation in general

In today’s increasingly knowledge-based economy, organizational studies have been emphasizing the factors behind the ability to produce influential innovations. Innovation can be described as a fundamental organizational output as it has a direct effect on firm viability as well as an impact on social and economic change.

At macro level, innovation and especially technological innovation is crucial for country’s economic growth (Schumpeter, 1943; Solow, 1957; Hui et al., 2017) At micro level, innovation capacity indicates firm’s long-term competitive advantage (Porter, 1992; Hui et al., 2017). According to famous economic theory, long-term productivity growth is a consequence of mainly knowledge development (Schumpeter, 1949) and technical change (Solow, 1957). Furthermore, R&D is a key factor of technical change (Romer, 1990). Schumpeterian endogenous growth theory states that R&D expenditure affect positively productivity growth. (Moncada & Castello, 2016; Schumpeter, 1949).

However, measuring technology has for long been a question. One traditional measure by Solow (1957) takes technology as a residual from a production function. However, the residual also contains the measurement error from the production function estimation measuring productivity only indirectly. Second tradition is to measure observable proxies for technical change such as research and development (R&D) expenditures as well as patent counts and citations. (Bloom & Reenen, 2002). According to Heimonen (2013), some studies approximated innovation with intellectual property rights such as patents, utility models, registered designs and trademarks as in others innovation is described as the intentional introduction and application within a role, group or organization of ideas, processes, products or procedures, new to the relevant unit of adaption, designed to benefit the individual, group, organization or wider society.

Research and development (R&D) indicators such as R&D intensity are also increasingly studied and used for international comparisons and targets for policies. However, for policymaking, it is important to observe whether the differences are intrinsic due to firm-level underinvestment in R&D or structural due to sector differences (Moncada & Castello, 2016). The theoretical and methodological framework for corporate R&D intensity and the literature on the determinants of R&D investment in industry sub-groups is very recent and rather limited resulting in mixed results regarding different industries and firm variables. (Becker & Hall, 2013; Moncada & Castello, 2016).

Berghäll (2015) examines Finland's claimed structural shift to an innovation economy at the global technology frontier. A basis hypothesis states that when reaching the global technology frontier, countries need to base their growth models on innovation instead of investment. The paper finds it true that innovation raises efficiency in advanced economies but also that it is not significant in Finland. For Finland to increase efficiency and to catch-up the global technology frontier, more significant and important would be to improve education and new ICT technologies. In Finland, even in the leading high-tech industry, R&D impacts on productivity are weak measured by either efficiency, R&D intensity, technical change or the R&D elasticity, of output are rather weak, in contrast to labor elasticity, firm size and scale elasticity. (Berghäll, 2015).

I.B. Innovation and IPO

The subject of the relation between IPO and innovation is important as, in addition to economic growth (Solow, 1957), innovations play a critical role in the recent increase of initial public offerings (IPO) especially by technological firms (Bernstein, 2015).

A well-noted recent study by Bernstein (2015) indicates that going public has an effect on three dimensions of innovation activity: the creation of internally generated innovation, the productivity and mobility of individual inventors, and the acquisition of external innovation. The main hypotheses include a theory that selling equities publicly in frictionless financial markets should not affect subsequent innovation activity. However, under financial frictions, going public improves firms' access to capital, which can lead to an increased innovation activity. On the other hand, agency problems associated with the transition to public equity markets may undermine firm incentives to innovate. Based on these arguments and results similar to other studies, I construct my main hypothesis H1.1 that going public has no effect on innovation and H1.2 that going public decreases innovation novelty.

Also, other research on the relationship between public versus private ownership structures and incentives to invest in innovative projects suggest that going public drives the exploiting of existing ideas while private firms have greater tendency to explore new ideas (e.g. Huasheng et al., 2013). Most probable reason behind this is that public firms are more transparent to outside investors encouraging them to reduce the risk-taking activities. Public companies have tighter disclosure requirements on e.g. interim earnings reports and annual reports as well as on analyst coverage. Moreover, public firms can adjust to possible bad news by an early exit strategy shielding insiders from failures and inclining their motivation to invest in innovative projects. On the other hand, prices of public securities react quickly, which incentivize insiders to go with conventional and quickly cashable projects even if it had a lower net present value than its alternative (Ferreiray et al., 2012).

Hui, Hanya and Zhang (2017) analyze the effect of the stock market and IPO on firm innovation with a unique Chinese firm-level data and find that both the quantity and quality of firm innovation activity as well as scope beyond core business increases after IPO. There is, however, a variation across financial constraints, corporate governance, and ownership structures. Furthermore, studies have shown that IPOs encourage firms to increase the number of inventors and helps in retaining existing inventors. IPO also has been shown to increase firm's Tobin's Q (total market value/total asset value of a firm) in the long run along with innovations. (Hui et al., 2017)

Stock market is an important resource of capital for firms and thus an initial public offering (IPO) provides access to equity financing with lower cost than debt financing spurring firm's innovation activity (Hall & Lerner, 2010; Hui et al., 2017). According to Holmström (1989), the payoff of long-term, idiosyncratic nature of innovation is heavily skewed and risky making debt financing less efficient. This access to equity financing could make IPO firm to pursue more innovation activities. On the other hand, existing corporate finance literature refers to agency problems that weaken the operation efficiency after an IPO (Berle & Means, 1932; Jensen & Meckling, 1976).

The same applies to innovation activities because risk of the innovation can be noticeable and risk the job for the manager weakening innovativeness due to career concerns. Innovation can also require more time and effort possibly leading a manager to settle with less innovation effort as IPO follows with weaker investor monitoring. Considering all the trade-offs, the possible increase or decrease of firm innovation after IPO depends on empirical question. (Hui et al., 2017)

Wies and Moorman (2015), on the other hand, state that listing firms will increase their innovation levels and variety of each innovation but reduce their innovation riskiness and with fewer breakthrough innovations and fewer new-to-the-firm innovations. Based on this, I conduct my third hypothesis H1.3 that going public increases the number of innovations and patents.

Bernstein (2015) also points out that transition to public equity markets might be conducted due to ambition of a future merger or acquisition. He concludes that acquisitions can be used for various reasons one of them being the possibility to buy external technologies. He shows that firms rarely acquire external patents through M&A before the IPO but following it the patent portfolios' ratio of external patents increase to 31%. Bena and Li (2014) Show that companies with greater number of patents and low R&D expenses are acquirers, while companies with high R&D expenses and minor patenting productivity are targets. Moreover, technological synergies between the transaction companies leads to positive outcomes and synergies altogether are important drivers of acquisitions.

Other hypotheses presented by Bernstein (2015) rationalizing the incline in innovation development after IPO include for example a *Career Concerns Hypothesis* based on a variation of the career concerns theory and interests of the manager and shareholders. Managers want to retain their job and shareholders accuse managers of innovation failures leading to career concerns and an aversion to innovation. Another concern is *Quiet Life Hypothesis*, which is based on the idea that innovation is a difficult task that imposes a private cost on the manager deterring the manager from innovation.

In regards the economic importance and probable benefits it is rather surprising that companies' tendency to develop their innovations declines following their IPO. Bernstein (2015) finds that even though 75% of firms he examines, state in the "use of proceeds" section in their IPO filing prospectus to use proceeds from their IPO for technological development and innovation, their innovation quality declines.

I.C. Innovation and age

There have been rather few studies of the relationship of initial public offering on innovation as well as on the relationship between organizational age and the ability of firms to produce technological innovations. Moreover, within scholars, there has been a lot of debate about the effects of aging on organizational functioning. Sørensen and Stuart (2000), on their side, examine the relationship between organizational aging and innovation processes of high-technology industries based on two contrary hypotheses: that aging increases innovation and that with age innovations become outdated as firms are too slow to answer to the continuous external developments. They find that these consequences are closely related reflecting trade-offs in organizational learning and innovation processes. (Sørensen & Stuart, 2000).

On one hand, aging may improve innovation activity through accumulated experience and possible more frequent innovation with greater significance than those of younger enterprises. On the other hand, a negative effect of aging on innovation would indicate that aging decreases the ability to generate new innovations.

Many scholars suggest that large size is associated with high organizational complexity (Blau & Schoenherr, 1971) as well as declined responsiveness and reduced innovation levels (Aldrich & Auster, 1986). Schumpeter (1942), however, suggests that larger organizations use their extra resources in innovations to innovation which, along with their market power, further appropriates their returns. Along age, firms' current innovations will elaborate and enhance older technologies. However, if age is connected to obsolescence, innovative outputs may become irrelevant to current environmental demands and age becomes a disadvantage. (Abernathy, 1978; Tushman & Anderson, 1986).

The innovativeness age from the Finnish IPO firms used in this paper is included in the Sfinno data as the difference between the commercialization year of the specific innovation and the time that the firm first entered the Finnish company register.

I.D. Innovation, R&D and subsidies

For examining corporate R&D expenditures, Becker and Hall (2013) propose five intrinsic determinants: firm or industry specific economic and financial factors, product market competition, public policies, location and endowment, and the presence of foreign R&D. Following the matter, many empirical results indicate a positive correlation between R&D investment and sales growth (Herrera & Sánchez-González, 2012; Morbey & Reithner, 1990) as well as with productivity. The effect of cash flow on R&D investment are mixed with mostly significant positive effects or insignificant effects (Moncada & Castello, 2016)

Jain and Kini (2008) find that diversification and intensity of industry-adjusted capital expenditures have a positive relation to changes in operating performance. However, they do not find a consistent relation between industry-adjusted R&D expenditures and changes in operating performance. Their analysis suggests that management's commitment to R&D spending diversifying product portfolio before issue enhance longer viability of IPO issuing firms. Long-run post-IPO performance can be enhanced by strategic investment decisions made just prior to going public as there is a likely lag between making the investments and their influence on performance. (Jain & Kini, 2008). Ravenscraft and Scherer (1982) find evidence of a mean lag of four to six years between R&D investments and profitability.

Moreover, public policy support by tax credits and direct R&D subsidies have been found to have positive effects on firms' R&D investment. (Bloom et al., 2002; Hall et al., 2016; Moncada & Castello, 2016). Evidence on the "funding gap" for investment innovation is surveyed by Hall and Lerner (2009) focusing on financial market reasons for underinvestment and conclude that while there are high costs of R&D capital, partly mitigated by venture capital, for small and new innovative firms the evidence for high costs of R&D capital for large firms is mixed. Nonetheless, internal funds to innovation investments appear to be preferred by large established firms. (Hall & Lerner, 2009).

R&D subsidies are also shown to increase private R&D activity significantly in small firms driving the sale of products new for the firm. However, large firms that received a subsidy increased investment only in technological development and thereafter improved the sale of products new to the market. (Herrera & Sánchez-González, 2012).

The argument states that the output of innovation resources is the non-rival knowledge of how to make new goods and services. Along the openness of knowledge, the investing firm cannot seize the returns to the investment in knowledge. Thereafter firms are unwilling to invest which leads to under-provision of R&D investment in the economy. The issue can be solved using intellectual property protection, subsidies, or tax incentives after which it can still be difficult or costly to finance R&D investments with external sources (Hall B. & Lerner, 2009).

When it comes to the criteria for receiving a public subsidy for an innovation, for example, Tanayama (2007), introduces that Tekes' (Finnish Funding Agency for Technology and Innovations) most important criteria for project evaluation for public funding are the technological challenge, novelty for markets and market risk. Thereafter, I conduct a hypothesis H2.1 that can be examined with the data of this study: More complex and novel innovations need and receive more easily public subsidies.

I.E. Innovation and performance

There is various research on the impact of variables related to firm and offering characteristics, ownership structure, governance, venture capital participation, and investment bank prestige on post-issue performance both in the US and international markets but relatively little research on innovation performance (Jain & Kini, 2008).

Tested with British patenting data by Bloom and Reenen (2002), patents are shown to statistically significantly impact the firm-level market-value and productivity. Analyzing activity whose pay-off might be only for near future, market value is an appropriate measure being forward-looking. However, the study indicates that patents have an immediate impact on market values but take time to affect productivity. The statement forms the basis for my hypothesis H3.1 that innovation has an immediate positive effect on company value. This can be through the fact that the new products and processes covered by the patents take time to be implemented with new capital equipment and training and possible further expenses on R&D and advertising. However, patents provide exclusive rights to the new technologies giving an option to wait the execution of these sunk costs investments generating valuable real options. When market uncertainty is higher, the value of real options increases and, reduces the impact of new patents on productivity. (Bloom & Reenen, 2002).

Castellacci and Zheng (2010) investigate the relationships between technological regimes and productivity performance of Norwegian firms and whether the relationship differs in different Schumpeterian innovation patterns. Their results indicate that total productivity growth is mainly achieved through technical progress, while technical efficiency has on average decreased. Technological regime characteristics are important for firm productivity growth, but not technical progress and efficiency as estimated model works differently in the two Schumpeterian regimes. Schumpeter Mark II industries is more dynamic environment for technical progress, while efficiency change has been more important in Schumpeter Mark I markets. In a Schumpeter Mark II regime, large incumbent innovators may lead productivity growth within the oligopolistic markets. On the other hand, in Schumpeter Mark I industries, productivity might be driven by intense competition by disruptive, more productive innovators (Foster et al., 1998; Castellacci & Zheng, 2010).

I.F. Innovation and complexity

One of the dependent variables of this study is innovation complexity. It has the most observables among the innovation variables in the Sfinno data. However, innovation complexity appears only in few studies.

By one description, complex innovation means that it includes more than one dimensions which can lead to its harder understandability and implementation (Torugsa & Aeundel 2016; Goffin & Mitchell, 2010). Adding to the difficulty to implement might consequently increase the risk of failure (Gopalakrishnan & Damanpour 1994). Thus, greater number of investments could be required to reduce this risk. Goffin and Mitchell (2010) state that multi-dimensional (complex) innovations are likely to require different development factors than single-dimension innovations. Innovation complexity can depend on various dimensions. For example, an innovation can be complex indirectly due to being a transformative innovation that requires changes to existing organizational routines.

One study by Torugsa and Aeundel (2016) examined the number of dimensions of significant innovations of Australian Government employees as a proxy for innovation complexity and found that an increase in complexity increases barriers for innovation implementation in workplace. In addition, complex innovations are found to be more likely in decentralized workplace with broader idea sources and encouraged creativity. However, according to their study, innovation complexity has a positive correlation with beneficial outcomes in the public sector encouraging interest in them. One example of positive outcomes is that with more simultaneous dimensions, the probability of at least one generating a valuable outcome increases among the uncertain payoffs. (Torugsa & Aeundel, 2016; Damanpour et al., 2009).

In this study, complexity is divided into four categories according to the Sfinno data with following descriptions from the Sfinno Codebook: *1) High complexity:* Innovation is a system consisting of several functional parts, development is based on several disciplines. (Examples: paper machine, mobile phone network, cruise ship), *2) Medium artefactual complexity / high developmental complexity:* Innovation is a unit, development is based on knowledge bases from several disciplines. (Examples: pharmaceuticals, software, generator), *3) Medium artefactual complexity / low developmental complexity:* Innovation is a unit, development is based on knowledge base from one discipline. (Examples: electronic wheel chair, drill), *4) Low complexity:* Innovation is a single coherent unit. (Examples: glue-laminated timber, mobile phone cover)

II. Hypotheses

Here I present my hypotheses for the empirical examination. My main hypotheses on innovation and IPO include a theory that selling equities publicly in frictionless financial markets should not affect subsequent innovation activity. However, under financial frictions, going public improves firms’ access to capital, which can lead to an increased innovation activity. On the other hand, agency problems associated with the transition to public equity markets may undermine firm incentives to innovate. (Bernstein, 2015). Thus, based on literature as discussed in section I, I first present my main hypotheses on innovation and IPO after which I present my other hypothesis for relevant questions on innovation and subsidies, performance and R&D and capital expenditure that are further examined. Parentheses include the main scholar whose research I base the hypothesis on.

II.A. Innovation and IPO

H1.1 Going public has no effect on innovation. (Bernstein, 2015).

H1.2 Going public decreases innovation novelty. (Bernstein, 2015).

H1.3 Going public increases the number of innovations and patents. (Wies & Moorman, 2015).

II.B. Innovation and subsidies

H2.1 More complex and novel innovations need and receive more easily public subsidies. (Tanayama, 2007).

II.C. Innovation and performance

H3.1 Innovation has an immediate positive effect on company value (Bloom & Reenen, 2002).

II.D. Innovation, R&D and capital expenditure

H4.1 Innovation activity increases prior R&D spending but has no effect on capital expenditure. (Cassima & Vaugelers, 2002).

III. Data and Sample Construction

The data in this analysis includes information on Finnish IPO filings, unique innovation data hand-collected by VTT, Finnish national patent data, financial information, and information on other firm characteristics.

III.A. IPO Filings

To identify all Finnish IPOs, I collect data on Finnish IPO issues available from SDC Platinum database. The initial data comprises of 78 different Finnish firms that have concluded their initial public offering during 1988 to 2015. However, following the literature, to measure the long-term effects of IPO on innovation, I look the effects five years before and after the IPO concluding the IPO sample period to 1988-2012 and reducing the potential sample firms to 39 IPO firms. The final used samples vary according to other data available. Among these 39 IPOs, 37 are listed on main NASDAQ OMX HELSINKI list and only two companies, Siili Solutions Plc and United Bankers Plc, that are currently listed on First North Helsinki. The Helsinki Stock Exchange has been operating since 1912. There are currently 139 companies quoted on the NASDAQ OMX HELSINKI list (regulated market) and 21 on the First North Helsinki list (multilateral marketplace) (NASDAQ, 2017).

III.B. Innovation data

My main data is my selection of a Sfinno dataset that is hand-collected by VTT Technical Research Centre of Finland Ltd. I received the data through a contact person in VTT and was able to select the variables for the final extract from their Sfinno Codebook that explains all variables. To be able to match all the needed Finnish IPO firms, I searched through the company names in my SDC data and looked whether they were still in use, whether the company name had changed for example through internal decision or M&A or whether there were some other relevant sub-names or affiliates whose Y-codes I then searched for Finnish corporate identification. The data includes observations and information from Finnish companies defined innovative by VTT and their published innovations collected from different magazines as well as data from surveyed company representatives on the innovations. The initial VTT Sfinno innovation data comprises of 34 companies that have been listed in the Finnish stock exchange of which 18 are used for my final data sample for table I analysis. This is due the limited availability of important variables (65 innovation observations).

The chosen innovations variables from the Sfinno data that I found important and used in regression analysis in this study described in the Sfinno codebook were innovation's 1) "complexity of innovation", measured on ascending scale from 1 to 4 as explained in section I.F, 2) "degree of novelty of the innovation from the firm perspective", measured on ascending scale from 1 to 3, 4) & 5) "degree of novelty of the innovation from the perspective of the Finnish market/global market" 6) "Is there a patent application for the above-mentioned innovation? (Patent pending)" 7) "Have you received a public subsidy for the development of the innovation?". Complexity of innovation (1) Is the only one of these that has been collected form magazines and thus the most observed while the other used information is collected by surveys.

III.C. Patent data

For additional support for analysis, I look at Finnish national patent data. The patent data is received from Finnish Patent and Registration Office PRH who were willing to conduct and send for free a compact dataset of these national patent applications in Finland matched for my sample companies. The data comprises of 1313 patent applications for 24 different listed companies. Of the applied patents 852 (74%) were granted and the rest being denied or still under process. There is on average a 1149 days' so 3 years' and 2-month period between the application date and the approval date of the patent. The data is, however, insufficient alone for broader conclusions as the companies can also apply for various international patents so the national patents might count only for one part of the total patent portfolios. This is also a trend in the current global business environment and might face an increase after IPO for which one major reason can be internationalization ambitions (figure III). In figures II and III I use concise statistics from PRH public database on overall Finnish and international patenting activity over time. Even though patent citation data would have been appropriate measure for patent quality following the literature, it was not available for free form PRH and thus this research does not take it into consideration.

III.D. Financial data and other firm characteristics

My analysis also includes company financials and Finnish market data (OMXH price index and net returns) for Finnish listed companies searched on Datastream database. Financial data and company specific stock price indexes and net returns are in company-level yearly measures and OMXH index is used also as yearly averages. I match the names of the companies manually to those from SDC and delete the rest of the companies.

For each financial balance sheet or financial statement item or key figure, that are extracted from Datastream for each company for a period of 1988-2014, I first searched the number corresponding the company's IPO issue year and extract a dataset of five years prior to five (or less) years post IPO figures. After that I take both and average and a mean of the company specific financials and take their change around IPO.

According to the innovation literature, I first attempted to include the following financials: R&D of total assets (or sales), capex of total assets (sales), ROE, ROA, debt of total capital, depreciation, depletion and amortization, net sales as well as enterprise value (EV). However, after taking away all blanks, the dataset becomes rather small with only 32 companies' observations. Moreover, due to the small sample, conducted regressions do not give any significant results. Thus, I decide to leave them out of this study and suggest more profound research on a broader sample of Finnish or Nordic companies on these average financials around IPO. I also lack enough data on firm size, such as firm turnover and number of employees, because even though Sfinno data includes these variables, there are too few observations to gain significant results.

Nevertheless, reported in table III, I find more significant and interesting results when looking at simple yearly financials EV, R&D of assets, Capex of assets and simple measure whether an innovation has been commercialized or not at the same year.

IV. Empirical Strategy

In this section, I provide predictions for the empirical tests that follow. I begin the empirical analysis by testing four predictions with OLS regression models which are all estimated with R. The results are presented in section V. where, after these models in the end, I will introduce other information with three (I-III) figures.

IV.A. Innovation characteristics

As my main method, I conduct an instrumental variable analysis with a multivariate regression model to examine the main innovation characteristics. I compare the long-run innovation of firms that go public. The models are estimated using OLS model with firm-level variables including robust standard errors and examining whether the coefficient' is statistically significant at the 10%, 5%, or 1% level. I include firm age to control for firm life-cycle effects. As additional robustness check I conduct heteroscedasticity tests with R for each regression.

As a baseline specification for instrumental variables approach, I estimate the following multivariate regression:

$$Y_{inno}i = \alpha 1 + \beta 1\_IPO_i + \beta 2\_log(1{+}InnovativenessAge_i) + \beta 3\_Hightech_i + \beta 4\_Subsidy_i + \nu k + \varepsilon_i \qquad (1,2,3,4,5,6)$$

where $Y_{inno}i$ is the examined dependent innovation characteristics: 1) complexity, 2) high complexity, 3) novelty for firm, 4) novelty for Finnish markets, 5) novelty for international markets, 6) patent application, $\beta 1\_IPO_i$ captures the causal effect of an IPO on innovation outcomes, $\beta 2\_Log(1{+}InnovativenessAge_i)$ returns the logarithm of one plus firm age at the time of commercialization since firm registration, $\beta 3\_Hightech_i$ is a dummy variable equal to one if a firm is classified for high-tech industry due to its primary line of business (SDC High Tech Insutry code), $\beta 4\_Subsidy_i$ is a dummy variable equal to one if the firm has received a subsidy for the development of the innovation, and zero otherwise. The model includes firm fixed effects (νk) to control for unobserved heterogeneity, and ε_i, is an error term ~N(0, a). If the conditions for a valid instrumental variable are met, $\beta 1$ captures the causal effect of an IPO on innovation outcomes. Under the null hypothesis H1.1. that going public has no effect on innovation, $\beta 1$ should not be statistically different from zero. However, under the contrary hypothesis H1.2. that going public decreases innovation novelty, $\beta 1$ should be negative in regressions 3), 4) and 5) on novelty.

IV.B. Innovation and subsidy

To examine whether receiving a subsidy is dependent on the innovation characteristics, I regress a binary variable equal to one if the firm has received a subsidy for the development of the innovation, and zero otherwise.

$$Ysubsidy_i = \alpha 1 + \beta 1\_IPO_i + \beta 2\_Hightech + \beta 3\_Log(1{+}InnovativenessAge_i) + \beta 4\_Complexity_i + \beta 5\_Patent + \beta 6\_Noveltyfirm + \beta 7\_NoveltyFI + \beta 8\_NoveltyIntern + \nu k + \varepsilon_i \qquad (7)$$

where the added variables are $\beta 4\_Complexity$ measuring innovation complexity on ascending scale from 1 to 4, $\beta 5\_Patent$ as a dummy variable equal to one if the firm has applied for a patent for the innovation, $\beta 6\_Noveltyfirm$ measuring novelty of the innovation from the firm point of view on ascending scale from 1 to 3, $\beta 7\_NoveltyFI$ as a dummy variable equal to one if the innovation is new to Finnish markets and $\beta 8\_NoveltyIntern$ as dummy variable equal to one if the innovation is new to international markets. Firm fixed effects (νk) are included.

Under the null hypothesis H2.1. More complex and novel innovations need and receive more easily public subsidies, $\beta 4$, $\beta 6$, $\beta 7$ and $\beta 7$ should be positive.

IV.C. Innovation and EV

To study whether the enterprise value (EV) is dependent on the innovation activity, I use dummy variables equal to one if there has been an innovation on the same year or on the previous year from when the EV is observed. I conduct three different regressions first with both, same and previous year dummies after which I test them separately as placebo tests. I also include firm fixed effects (νk) and the common OMXH index to control for the market performance (β3_OMXH$_i$).

I use an OLS regression:

$$Y_{EV} = \alpha 1 + \beta 1\_Innovationsame_i + \beta 2\_Innovationprevious_i + \beta 3\_OMXH_i + \beta 4\_Subsidy_i + \nu k + \varepsilon_i \quad (8)$$

which, under the null hypothesis H3.1 that innovation has an immediate positive effect on company value, β1 and β2 should be positive.

IV.D. Innovation and R&D/sales and capex/sales

From another point of view, I look if innovation commercialization in the same, previous or one to five years after the observed R&D/sales and capex/sales ratios affect these financial measures and the other way around. These financial ratios are closely studied in innovation and financial literature as well and can be used as indicators of company's investment and innovation activity. I include firm fixed effects (νk) and the common OMXH index (β_OMXH$_i$).

To model the relation, I conduct a following OLS regression first (11) R&D/sales as the dependent variable and then (12) Capex/sales as the dependent variable:

$$Y_{RD}\ (Y_{capex}) = \alpha 1 + \beta 1\_Innovationsame_i + \beta 2\_Innovation1yearbefore_i + \beta 3\_Innovation1yearafter_i + \beta 4\_Innovation2yearsafter_i + \beta 5\_Innovation3yearsafter_i + \beta 6\_Innovation4yearsafter_i + \beta 7\_Innovation5yearsafter_i + \beta 8\_OMXH_i + \nu k + \varepsilon_i \quad (11, (12))$$

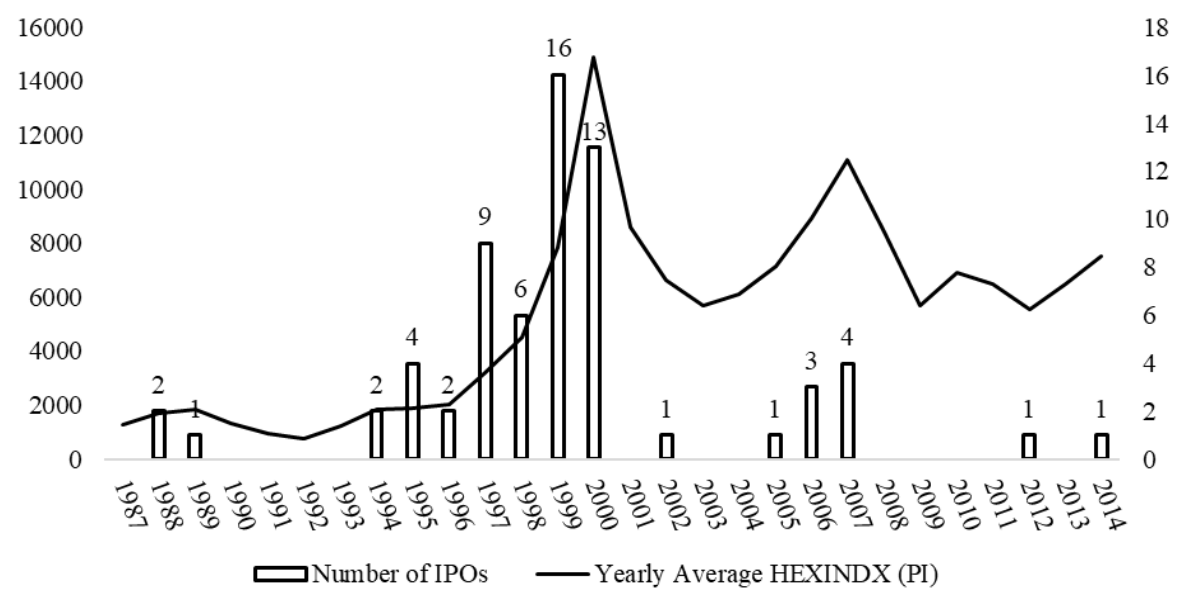
which, under the null hypothesis H4.1. that innovation activity increases prior R&D spending but has no effect on capital expenditure, at least β1 and β*3* and possibly β*5* forward should be positive with regression (11) while with regression (12), β1 should not be statistically different from zero.

V. Results

Figure 1 depicts the distribution of IPO sample by year in Finland in relation to average yearly OMXH stock index for period 1987-2014. The total number of this sample IPOs is 66. Confirming previous literature of market-timing, IPO waves and IPO climate driving the decision to go public (e.g., Brau & Fawcett, 2006), I observe a high number of IPOs when the market index is high and less in low market periods. Measured by the output loss the depression of the 1990-1993 in Finland was the most severe peacetime crises of the 20th century. After which the economy started to recover from 1993 till 200 (Jonung et al., 2009). In the beginning of the 21st century companies faced a crucial market drop following the dot-com crash. The highest index being 14885.40 (average) in 2000 with 13 IPOs following the most active year with 16 IPO and 7833.56 average index. Three-month average net return of the sample IPOs is 33.2 % but 10.9 % if three companies over 200% net returns are excluded while the three-month median net returns are a modest 3.0 percentage.

Figure I

IPO distribution and OMXH market index by year in Finland, 1987-2014



The first set of results explores the effect of going public on six innovation characteristics: complexity, high complexity, novelty for firm, novelty for Finnish market, novelty for international market and patent application in columns 1-6 respectively. All specifications follow the model described in Section IV.A., controlling for industry fixed effects and for all six different dependent variables. I also control for company age, the high-tech dummy variable and subsidy dummy variable while also examining their effect. Robust standard errors are reported in parentheses.

Columns (1) and (2) in Table I present the regression results on innovation (1) complexity and (2) high complexity separately. High complexity is the fourth and highest level of the Sfinno complexity levels[1]. Results indicate that the overall model (1) is significant ($F(20) = 3.09$, $p < .01$) but the model (2) is not ($F(20) = 0.39$, $p > .1$). The variable coefficients in column (1) are not significant. When looking at the highest complexity (2) level alone as a binary variable, the results indicate a slightly positive 0.121, and significant at a 10% level, effect of receiving a public subsidy. This is in line with part of the hypothesis H2.1 that more complex (and novel) innovations need and receive more easily public subsidies. Looking at the effect of IPO on the innovation novelty from the firm perspective, the model (3) for estimating the effect on new-to-the firm innovations, is not quite significant ($F(20) = 1.147$, $p > .1$). The results are partly contrary to H1.1. that IPO has no effect on innovation. In addition, the results suggest other independent measures to be tested as the intercept coefficient is large and highly significant. On the other hand, the negative -0.313 (though not significant) effect from firm age is in line with other studies (Bernstein, 2015; Sørensen & Stuart, 2000; Wies & Moorman, 2015).

[1] Sfinno data defines complexity with four levels: 1) High complexity: Innovation is a system consisting of several functional parts, development is based on several disciplines. (Examples: paper machine, mobile phone network, cruise ship), 2) Medium artefactual complexity / high developmental complexity: Innovation is a unit, development is based on knowledge bases from several disciplines. (Examples: pharmaceuticals, software, generator), 3) Medium artefactual complexity / low developmental complexity: Innovation is a unit, development is based on knowledge base from one discipline. (Examples: electronic wheel chair, drill), 4) Low complexity: Innovation is a single coherent unit. (Examples: glue-laminated timber, mobile phone cover)

Table I

Innovation characteristics

This table reports the effects of an IPO on the innovation characteristics. The table includes results from six regressions with different dependent variables from Sfinno data including innovation's 1) complexity, measured on ascending scale from 1 to 4; 2) high complexity, being a dummy variable equal to one on the most complex (level 4) innovations; 3) novelty for firm, measured on ascending scale from 1 to 3; 4) novelty for Finnish markets, being a dummy variable equal to one if the innovation is new to Finnish markets; 5) novelty for international markets, being a dummy variable equal to one if the innovation is new to international markets 6) patent application, being a dummy variable if there is a patent pending for the innovation. Independent variables and control variables are kept same for each regression. *IPO* is a dummy variable equal to one if a firm issues an IPO filing, and zero otherwise. *Log(Innovaitveness Age)* returns the logarithm of one plus firm age at the time of commercialization since firm registration, and zero otherwise. *High-Tech* is is a dummy variable equal to one if a firm is classified for high-tech industry due to its primary line of business (SDC High Tech Industry code), and zero otherwise. *Subsidy* is a dummy variable equal to one if a firm has received a public subsidy for the development of the innovation, and zero otherwise. The model is estimated using OLS regressions in all columns. All columns control for firm fixed effects. Robust standard errors are in parentheses. Robust standard errors are reported in parentheses. *, **, and *** indicate that the coefficient is statistically significant at the 10%, 5%, and 1% level, respectively.

Dependent variable	Complexity	High complexity	Novelty for firm	Novelty for Finnish market	Novelty for international markets	Patent application
	(1)	(2)	(3)	(4)	(5)	(6)
IPO	0.146 (0.220)	0.045 (0.095)	0.010 (0.310)	-0.385** (0.190)	0.346* (0.197)	0.018 (0.156)
Log(Innovati-veness Age)	0.408 (0.262)	0.006 (0.089)	-0.313 (0.290)	-0.163 (0.178)	0.138 (0.184)	-0.243 (0.146)
High-Tech	0.193 (0.139)	-0.046 (0.113)	-0.136 (0.369)	-0.562** (0.226)	0.659*** (0.234)	0.745*** (0.185)
Subsidy	0.105 (0.206)	0.121* (0.060)	0.026 (0.196)	-0.083 (0.121)	0.022 (0.125)	-0.015 (0.099)
Intercept	0.795 (0.850)	0.028 (0.367)	3.537*** (1.198)	1.316* (0.735)	-0.294 (0.761)	1.122* (0.602)
Observations	65	65	65	65	65	65
Companies	18	18	18	18	18	18
*R*2	0.384	-0.225	0.043	0.092	0.080	0.612
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

In support of H1.2. that going public decreases innovation novelty, I find that, even though the models (4) and (5) are not significant, yet close (4: $F(20) = 1.332$, $p > .1$; 5: $F(20) = 1.186$; $p > .1$), going public has a significant negative (-0.385, 5 % level) effect on (4) innovation novelty for Finnish markets. However, contrary to the hypothesis H1.2, results indicate a positive effect (0.346, 10 % level) on innovation novelty for international markets. This can be rationalized by the idea that internationalizing is one of the motives to go public and might drive international innovations, which is also supported by figure III showing an overall increasing trend in international patents. Moreover, the variable High-tech (indicating whether the firm operates within high-tech industry based on its core business) has significant effect on the innovation novelty being negative (-0.562, 5 % level) for the Finnish markets and positive for the international markets (0.659, 1 % level). In the sample, 47.7 percentage are high-tech companies.

To the question whether going public increases patenting on innovations, column (6) in Table I, indicates that the only independent variable coefficient that is significant is Hight-tech (0.745, 1 % level). The result is logical as high-tech companies are likely to produce new innovations that are suitable and preferred to be protected with patents. Literature also shows that higher quality and scientifically more advanced innovations promise higher profits and are more likely to be patented (Moser, 2007). The overall model is significant (F(20) = 6.213, p < .01).

Table II

Innovation and subsidy

This table reports the effects of an IPO and Sfinno innovation characteristics on receiving a public subsidy as the dependent variable. *Subsidy* is a dummy variable equal to one if the firm has received a public subsidy for the development of the innovation, and zero otherwise. *IPO* is a dummy variable equal to one if a firm completes the IPO filing, and zero otherwise. *High-Tech* is a dummy variable equal to one if a firm is classified for high-tech industry due to its primary line of business (SDC High Tech Industry code), and zero otherwise. *Log(Innovaitveness Age)* returns the logarithm of one plus firm age at the time of commercialization since firm registration. C*omplexity* is a measure on ascending scale from 1 to 4. *Patent application* is a dummy variable equal to one if the firm has applied for a patent for the innovation, and zero otherwise. N*ovelty for firm* is a measure on ascending scale from 1 to 3. *Novelty for Finnish markets* is a dummy variable equal to one if the innovation is new to Finnish markets, and zero otherwise. *Novelty for international markets* is a dummy variable equal to one if the innovation is new to international markets, and zero otherwise. The model is estimated using OLS regression controlled with firm fixed effects. Robust standard errors are in parentheses. Robust standard errors are reported in parentheses. *, **, and *** indicate that the coefficient is statistically significant at the 10%, 5%, and 1% level, respectively.

	IPO	High-tech	Log(Innovati-venessAge)	Comp-lexity	Patent application	Novelty for firm	Novelty for Finnish market	Novelty for international markets	Intercept
Subsidy (7)	-0.227 (0.239)	-0.251 (0.330)	-0.386* (0.219)	0.267* (0.156)	-0.138 (0.228)	0.073 (0.117)	-1.055* (0.547)	-0.900* (0.527)	2.481** (1.015)
Observations	65								
*R*2	0.128								
Firm fixed effects	Yes								

When the model is turned around so that we look at the effect of IPO, high-tech, innovativeness age and innovation characteristics (complexity, patent application, etc.) on whether an innovation and its development has received a subsidy or not, I find in the table II results from equation (7) that only complexity of the innovation has a significant positive effect (0.267, 10% level) on the occasion of receiving a subsidy while innovativeness age (-0.386, 10% level), novelty for Finnish market (-1.055, 10% level) and novelty for international markets (-0.900, 10% level) have negative effects. Going public is not significant. These results would imply that hypothesis H2.1 that more complex and novel innovations need and receive more easily public subsidies, is right on complexity's positive effects but wrong with novelty because the coefficient of novelty for firm is not significant and those of market novelty are negative. However, there is a difference if the company's need a subsidy or if they even want a subsidy in the first place. The large positive and significant intercept predicts an important unobserved variable including for example firm's financial position, size and possible previous subsidies (Herrera & Sánchez-González, 2012). The suggested OLS model is not significant yet very close ($F(20) = 1.402$, $p > 0.1$) and the R2 is rather low (0.128)

In addition to the effect of IPO on innovation characteristics, I examine first the questions how innovation affects the firm value (EV) and then how it affects investments in R&D/sales and capex/sales. Equations 8,9 &10 in Table III, supports the hypothesis H3.1. that innovation has an immediate positive effect on company value. Column (8) results indicate that commercializing an innovation has a positive and significant (4.032, 10% level) effect on EV on the same year while the influence of the innovation on the following year's EV (lagged innovation's effect on EV) is positive but not significant (3.206). Columns (9) and (10) are conducted as placebo tests at which the single same year effect enforces a little (4.495, 5 % level) and the single lagged innovation effect becomes significant (3.770, 10 %). All the used OLS regression model are highly significant (8: $F(27) = 76.36$, $p < .01$; 9: $F(27) =79.02$, $p < .01$; 10: $F(27) = 78.78$, $p < .01$).

Equations (11) and (12) in Table III, reports the regression results of innovation's effect on (11) R&D/sales and (12) capex/sales ratios. The regression (11) results support the hypothesis H5.1. as they indicate that commercializing an innovation the same year as R&D/sales ratio is allocated has a slightly positive and significant (0.103, 10% level) effect on R&D/sales and commercialization one year after makes a firm to increase the R&D expenses as well (0.112, 5 % level). When it comes to capes/sales (12), innovating does not have a significant effect on the ratio. The average R&D/sales in the sample is 10.4% and the median is 0.3% while the average capex/sales in the sample is 5.2 % and the median is 2.8%. I do control for IPO, but that is rather unnecessary and unsuitable because as much as 83.3% (414/497) of the sample financial ratios were observed the same or following years after IPO issue year. OLS regression model (11) is slightly significant and (12) highly significant (11: $F(33) = 1.353$, $p < 0.1$; 12: $F(27) =3.086$, $p < .01$).

I also test for heteroscedasticity of the regressions with Breusch-Pagan test on R. I could rarely reject the null hypothesis that there is no heteroskedasticity at the 5% level implying that there is no significant heteroscedasticity in the models. Only when testing the regression on the innovation and R&D/sales I found a highly significant p-value of 5.322e-12 (1% level) as well as for the innovation output of novelty for firm a p-value of 0.01691 (5 % level).

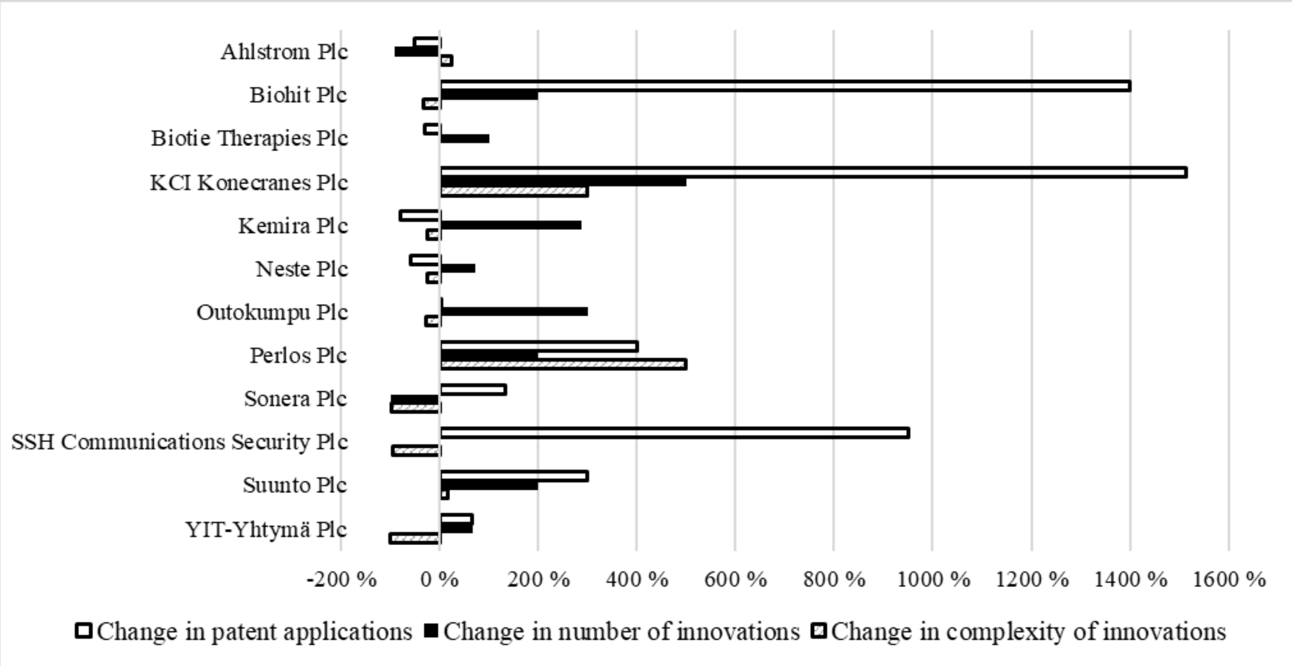
Table III
Innovation and EV, R&D/Sales and Capex/Sales

This table reports first the effects of nnovation on the enterprise value (EV) of the company with three regressions. with yearly EV as dependent variable while the examined independent variables are 8) *Innovation same year* which is a dummy variable equal to one if there has been an innovation the same year as the EV measure and *Innovation 1 year before* which is a dummy variable equal to one if there has been an innovation one year prior to the EV measure year as well as placebo tests 9) *Innovation same year* only; 10) *Innovation 1 year before* only. I control for yearly average OMXH index and include firm fixed effects. Second, the table reports the effects of an IPO, yearly average OMXH index and introducing an innovation on yearly 11) R&D/sales ratio and 12) Capex/sales ratio of the company. The columns (11) and (12) include results from two regressions with yearly R&D/Sales and Capex/Sales ratios as dependent variables. I examine the effect of innovation commercialized either on same year, 1 year before or 1-5 years after IPO as dummy variables. Thus, the regressions measure same year's, previous year's and following year's innovation's effect. Both the ratios have been assumed to be 0 if no value available. As control variable I include logarithm of yearly average OMXH index, Log(OMXH index), and include firm fixed effects. The model is estimated using OLS regression. Robust standard errors are in parentheses. Robust standard errors are reported in parentheses. *, **, and *** indicate that the coefficient is statistically significant at the 10%, 5%, and 1% level, respectively.

Dependent variable	EV (8)	EV (9)	EV (10)	R&D/Sales% (11)	Capex/Sales% (12)
IPO	-	-	-	0.243*** (0.063)	0.008 (0.017)
OMXH index	2.947 (3.296)	2.983 (3.300)	3.022 (3.304)	-	-
Log(OMXH index)	-	-	-	-0.049 (0.046)	0.014 (0.012)
Innovation same year	4.032* (2.300)	4.495** (2.279e)	-	0.103* (0.055)	0.016 (0.015)
Innovation 1 year before	3.206 (2.269)	-	3.770* (2.252)	-0.007 (0.055)	-0.002 (0.014)
Innovation 1 year after	-	-	-	0.112** (0.055)	-0.005 (0.015)
Innovation 2 years after	-	-	-	-0.061 (0.055)	-0.007 (0.015)
Innovation 3 years after	-	-	-	0.038 (0.055)	-0.006 (0.014)
Innovation 4 years after	-	-	-	-0.004 (0.055)	-0.004 (0.014)
Innovation 5 years after	-	-	-	-0.084 (0.054)	0.006 (0.014)
Intercept	-2.828 (4.659)	-2.552 (4.661)	-2.502 (4.667)	0.206 (0.381)	-0.114 (0.100)
Observations	437	437	437	497	497
Companies	25	25	25	25	25
*R*2	0.824	0.823	0.823	0.452	0.121
Firm fixed effects	Yes	Yes	Yes	Yes	Yes

Figure II
IPO effect on complexity and the number of innovations
and national Finnish patent applications

This figure reports the effects of an IPO on the innovation complexity and the number of innovations and national Finnish patent applications measured as the change in five-year averages before and after IPO. Complexity and number of innovations is counted from the Sfinno data. Complexity is chosen as the most observed innovation characteristic in the data. The patent application counts around IPOs are calculated from the PRH national patent data. The selection of the companies is due to the data available for these 12 companies for all three measures.



Next, I provide further information on Finnish companies' innovating and patenting activity in regards the effect of going public and distribution within national and international patent applications as well as within different industries.

A popular measure in innovation literature (e.g. Bernstein, 2015; Hui et.al., 2017; Wies & Moorman, 2015) on the question whether going public affects innovation activity is the change in patent or other innovation count and find them to increase. Figure II depicts the same result with Finnish IPO companies: the five-year average number of patent applications and innovations increases in most of the cases. The complexity of innovations, on the other hand, seems to decrease for most of the companies with KCI Konecranes Plc and Perlos Plc as notable exceptions. Some of the differences could be explained with limits in the data which might not capture all possible information for all the operating names of the companies. In regards of the small sample size, I do not conduct regressions leaving the significance of the results unknown. However, the increasing trend in innovation and patent count seems to be valid. Slight exceptions to the patent count change are Ahlstrom Pls, Neste Plc and Kemira Plc, for which one possible explanation could be a transition from national patents to international patents. The increase in the number of innovations and patents on the five-year window around IPO are in line with the hypothesis H1.3 that going public increases the number of innovations and patents.

Figure III shows us that patent applications filed by Finnish companies have been in nearly constant decline since 2001. The transformation towards international patent applications has been notable during the 21st century after which the overall patenting activity, in spite that to the US, faced a drop or slowed down during the crisis years of the end the 21st century. The United States as an exception, also international patents applied by Finnish companies has been in a new decline since the 2014 (Europe and Asia).

Moreover, Figure IV indicates that going public decreases the patents in the more traditional industries of while traditional industries of e.g. transporting (B), lightning and heating (F), metallurgy (C) face a slight increase and textiles and paper (D) decreases notably. Also, human necessities (A), fixed construction (E) and physics (G) increase. Electricity (H) seems to face a vast increase with prior Sonera Plc (TeliaSonera Plc) accounting for 69% of the patent applications. The data however, might not include all the necessary information from all operating company names and is limited in a sense that it includes only national patent applications but no international applications. Appendix I shows an industry distribution of the number of patent applications among Finnish IPO companies 1985-2009 (PRH data). Altogether however, the figure shows that industries B) performing operations and transportation and C) chemistry and metallurgy are the most active industries according to patenting activity. Moser (2007) also reveals that inventors within different industries have strongly varying tendencies to patent, suggesting that differences in technologies across industries are important factors of patenting.

Figure III

Applications filed by Finnish applicants in Finland and in other countries, 2001-2016

Figure III indicates the change in patent applications in Finland and internationally by Finnish patent applicants over time during 2001-2015/2016. The figure includes patent applications for Finland, Europe (EPO), the United States (USPTO), Japan, China and Korea together (JPO, SIPO, KIPO) as well as international applications (PCT). The data is collected from PRF online statistics.

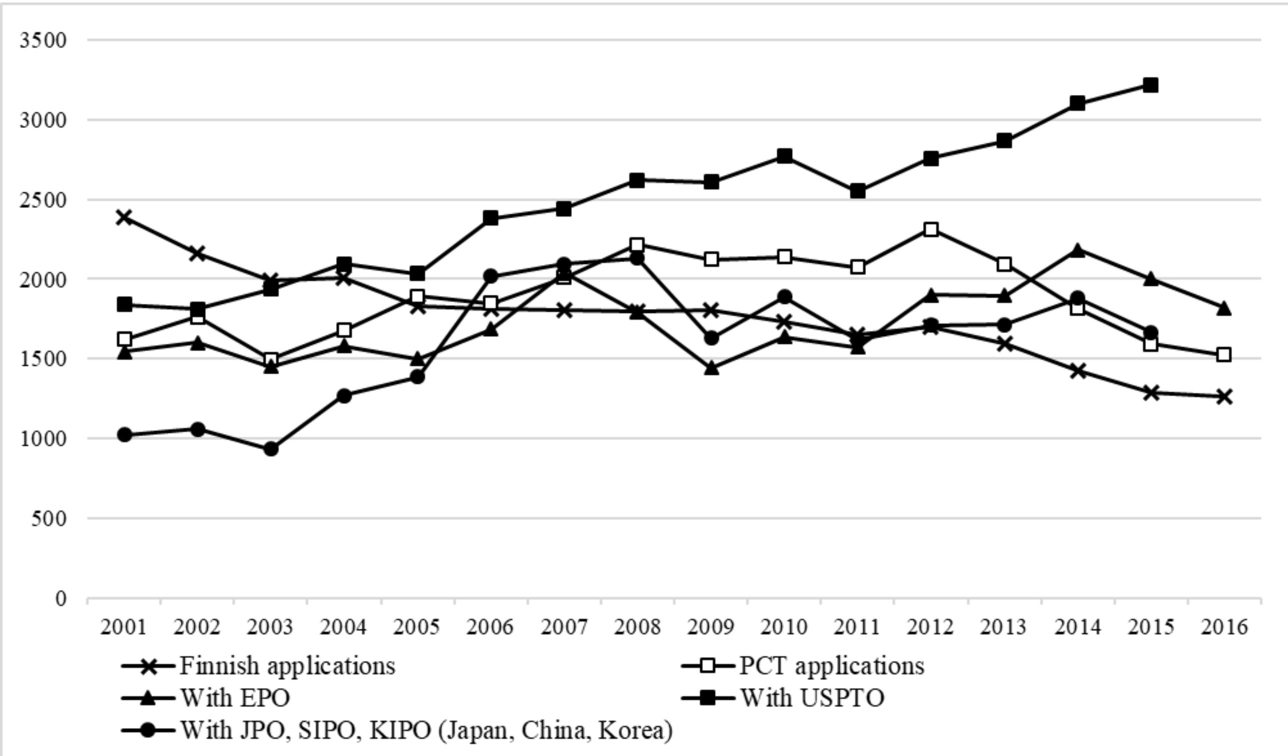
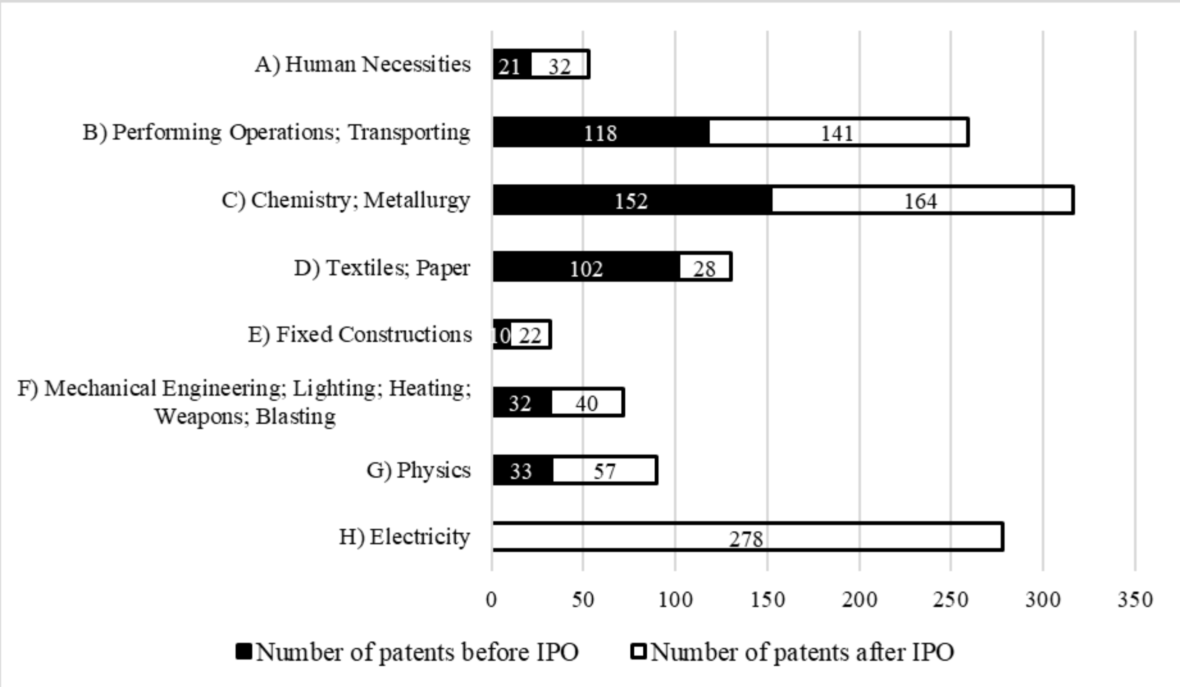


Figure IV

National Finnish patent applications by IPC classification before and after IPO

This figure reports the IPC (International Patent Classification) industry distribution of national Finnish patent applications. The figure is calculated based on the data received from PRH and the given IPC class 1. where the first letter indicates the main industry to which the innovation belongs. Industries are divided into eight categories according to the IPC classification (A-H, industry name in chart). The sample includes patent applications from 1985-2009.



VI. Limitations to Analysis

In this section I discuss some of the issues of the estimations made in this study. First, according to also Bernstein (2015) and Jain and Kini (2008), one of the concerns is the inherent selection issues arising from the decision to go public that challenge the identification of the effects of going public on innovation and firm outcomes. Due the IPO choice, post-IPO performance and innovating activity could be driven by reversion to the mean and life cycle effects, rather than the effect of becoming a publicly traded firm. However, the analysis of private firms is complicated due to data limitations. To address these issues, I use only public companies that have conducted an initial public offering, which however leads to an examination with no private firm control group. There is also a concern that cash-rich firms might have fewer and less complex or novel innovations due to probable higher litigation risk and thus mechanically generate the results in the paper.

Second, regarding the data on R&D/sales and Capex/sales in my sample, 19% perform no Capex/sales and as much as 48% perform no R&D or for some cases the ratio was assumed to be 0. Thus, if the modelled independent variables affect both the probability of conducting R&D (or capex) and the amount of R&D spending, estimating the specification on a sample that includes only R&D performing business units will bias the resulting parameter estimates due to truncation of the error term. However, like Wies and Moorman (2015), I assume that any unobserved variables affecting the likelihood of performing R&D are not correlated with the error term. For further robustness check, Tobin and GLS estimation models are suggested.

Another issue concerns the Sfinno data from questionnaires that is based on answers from randomly selected respondents and thus a possible source of bias could occur. However, this is unlikely to have a notable effect on the results as the respondents' initiatives to the data told should not be biased and the questions are quite straight forward and objective. Still, the questionnaire data limits the sample size significantly and the initial selection bias remains in the range of companies' innovations that have or have not received an answer. The problem is that there is no publicly-available objective data on the outcomes of innovation precludes testing the correlation between subjective and objective measures of outcomes.

In addition, I do not include year fixed effects, which could be recommended according to some literature. However, the innovativeness age variable captures some of the temporal effects in the absence of the time trend. I also suggest that size and year fixed effects and also industry fixed effects to be included, even though I currently have high technology dummy and company fixed effects. Regarding size, previous research has shown that some models of age effects fail to control for size and yield biased estimates of the age effects because there is typically a strong positive correlation between the two variables. Due to large organizations' tendency to be more bureaucratic comparing to the entrepreneurial and small companies, I expected that size would affect negatively on the innovation importance. (Sørensen & Stuart, 2000).

VII. Conclusion

This paper has analyzed the effects of going public on innovation characteristics and the number of patents and innovation, as well as the relationship between innovations and subsidy, R&D and capital expenditures. These effects were estimated using unique innovation data and by comparing Finnish companies that have conducted an IPO during 1988-2012.

The first set of results examined the effect of IPO on innovation characteristics. According to the findings, going public has significant effect only on innovation novelty of Finnish companies. Specifically, supporting one of the initial hypothesis that going public decreases innovation novelty, I find that going public has a significant negative effect on innovation novelty for Finnish market. However, contrary to the hypothesis, results indicate a positive effect on innovation novelty for international markets. This emphasizes firm's focus on internationalizing especially along going public. Statistics from Finnish Patent and Registration Office (PRH) support the finding showing that patent applications filed by Finnish companies have declined since 2001 while the transformation towards international patent applications has been notable disregarding the financial crisis in the end of the 21st century. Moreover, companies operating within high-tech industry tend to similarly pursue more novel innovation from international markets perspective but not from Finnish market perspective. They are also found to apply for more patents for their innovations.

Moreover, the study shows that Finnish companies' number of innovations and patents is found to increase after going public. The patent data also shows that performing operations and transportation as well as chemistry and metallurgy are the most active industries in Finland according to patenting activity. After IPO the patenting activity within textiles and paper -industry seems to have faced a steep decrease while patenting in electricity industry has increased the most.

The analysis on the innovation characteristics on the question whether an innovation and its development has received a subsidy or not, indicates that complexity of the innovation has a significant positive effect on receiving a subsidy while innovativeness age, novelty for Finnish market, and novelty for international markets have negative effects. Also, when looking at the highest complexity, the results indicate that receiving a public innovation subsidy drives the development and commercialization of highly complex innovations. The result on complexity is in line with the assumption that higher complexity tends to lead for more public funding, but the other results are not in line with the assumption of positive effects of novelty. However, the model lacks possible effects of firm's financial position, size and possible previous subsidies.

Finally, the study shows that there is an immediate positive effect of innovation on enterprise value (EV) on commercialization year that can be seen in the next year EV as well. In addition, I find that R&D expenses measured with R&D/sales ratio are increased in the same year and one year before commercializing of innovation. With capital expenditure, however, there is no significant relationship with innovation. This is in line with previous literature on the close link between investments in R&D and innovation activity.

The questions on innovation are important from both company and broader economic perspectives for future growth and competitiveness. This study on Finnish public companies that have conducted an IPO finds interesting results while it also suggests a need for future research. Topics for further research include extending the sample of this thesis to both public and private Finnish and for example Nordic or European countries for more profound geographical comparison. Another topic for further studies is to consider whether innovations are generated initially by the company gone public or through acquisitions or SEOs. The relationships between innovation and M&A as well as between innovations strategies and performance could be studied with, for example, VTT's Sfinno data for Finland.

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Appendix I

This table contains firm specific national Finnish patent counts and their IPC (International Patent Classification) industry distribution in1985-2009. The information is based on data received from Finnish patent and registration office (PRH).

	A) Human Necessities	B)Performing Operations; Transporting	C)Chemistry; Metallurgy	D) Textiles; Paper	E) Fixed Constructions	F)echanical Engineering; Lighting; Heating; Weapons; Blasting	G) Physics	H) Electricity
Ahlstrom Plc		8		1			7	
Biohit Plc	2	5	7					
Biotie Therapies Plc	4		11					
Comptel Plc							3	6
Eimo Plc		2						
Fortum Plc	2	3	26	3		13	4	1
Helsingin Puhelin Plc							2	27
KCI Konecranes Plc		34				3	1	2
Kemira Plc	30	19	107	33		13		1
Neste Plc	3	32	102	1	6	4	9	1
Nokian Tyres Plc		24			1	17		
Outokumpu Plc	1	58	56		1		22	3
Perlos Plc	2	18				2	1	1
PMJ Automec Plc		6					1	3
Rapala Plc	6	1						
Rautaruukki Plc		7	3		17			
Rocla Plc		6						
Sonera Plc							22	180
SSH Communications Security Plc							4	17
Stonesoft Plc								18
Suunto Plc		3					3	
Valmet Plc	2	33	1	92	1	17	10	
YIT Plc	1	1			5		1	
Together	53	260	313	130	31	69	90	260